

# WORLD METEOROLOGICAL ORGANIZATION GLOBAL CRYOSPHERE WATCH

REPORT No. 8

## CryoNet South America Workshop First Session

Santiago de Chile, Chile  
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World  
Meteorological  
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Weather • Climate • Water



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**FINAL REPORT  
DRAFT**



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## EXECUTIVE SUMMARY

*(Spanish version below)*

The 1st CryoNet South America Workshop was held on 27, 28 and 29 October in Santiago, Chile, with the attendance of 65 participants from 16 countries. The Workshop was sponsored by the World Meteorological Organization (WMO) through the Global Cryosphere Watch (GCW) initiative. Co-sponsors included the Ministry of Foreign Affairs of Chile; the University of Magallanes, Chile (UMAG); the Chilean Weather Directorate (DMC); the Chilean Water Directorate (DGA); the University of Talca, Chile (UTAL); and the company Geostudios, Chile.

GCW and CryoNet sessions were held during Days 1 and 2 at O'Higgins Hall, Ministry of Foreign Affairs of Chile, with presentations from experts of all participating countries. On Day 3 field work was conducted at Valle Nevado and El Colorado ski resorts, 60 km east of Santiago, visiting snow and meteorological stations operated by University of Chile and DMC, and learning practical experiences of snow cover characterization.

The opening of the session included welcoming words from Dr. Zhang Wenjian, Director of the Observation and Information Systems Department of WMO; Mr. Guillermo Navarro, Director of the Chilean Weather Directorate; Dr. Gino Casassa on behalf of the Rector of the University of Magallanes; Dr. Cedomir Marangunic, Director of Geostudios; and Minister Counsellor José Fernández, Subdirector of Maritime Affairs and Natural Resources of the Directorate for the Environment and Maritime Affairs, Ministry of Foreign Affairs, Chile. Ms. Mercedes Meneses, Head of Department of Environmental Affairs, Ministry of Foreign Affairs, Chile, made an introduction on behalf of the Local Organizing Committee.

The different sessions on Days 1 and 2 were led by Dr. Arni Snorrason, Chair, and Dr. Barry Goodison, Vice-chair of GCW Steering Group; Dr. Wolfgang Schoener, Chair of CryoNet Team; Dr. Jeff Key, coordinator of GCW implementation plan; Dr. Miroslav Ondras, Chief of WMO Observing Systems Division; and Dr. Gino Casassa, member of the GCW Steering Group.

The main objective of the 1st CryoNet South America Workshop was to identify stations/sites that could be selected for CryoNet in South America, discuss practices that should be applied and to foster the development of cryospheric activities in the region.

A final session on Day 2 was dedicated to the review of environmental regulations related to glaciers and the periglacial environment within the different countries represented in the Workshop, a topic of particular relevance to Chile in view of the glacier law initiative currently being discussed in Congress. The need for adequate cryospheric definitions was stressed in view of their legal implications.

The following agreements and action points were concluded:

1. There is high interest in the region to contribute to the CryoNet initiative.
2. National Representatives of CryoNet South America will be initially selected among the invited participants, in coordination with the national IACS correspondents.
3. Gino Casassa, National Representative for Chile, will follow up on item 2.
4. Each National Representative will contact the respective agencies, institutions and colleagues to remind them to complete the site questionnaire before 25 November 2014.
5. A Regional Group will be formed by consensus from the National Representatives.

6. Mexico will be included in the group, and the name CryoNet Latin America will be proposed.
7. Potential collaboration with the Latin America and the Caribbean (LAC) regional section of the International Hydrological Programme (IHP) of UNESCO will be proposed to the Snow and Ice Working Group of LAC.
8. A 2nd South America meeting is proposed to be held in the 2nd half of 2015.
9. The Regional Group will follow up on items 6, 7 and 8.

National representatives were nominated for Mexico, Colombia, Ecuador, Peru, Bolivia, Argentina, and Chile.

It was concluded that systematic long-term monitoring of the cryosphere is critically needed in Latin America, especially in view of the drastic changes experienced by snow and ice masses at a continental scale. In this regard CryoNet Latin America will provide a key contribution to the global CryoNet initiative.

## RESUMEN EJECUTIVO

El 1<sup>er</sup> Taller CryoNet Sudamérica se llevó a cabo los días 27, 28 y 29 de Octubre en Santiago, Chile, con participación de 65 personas de 16 países. El Taller fue patrocinado por la Organización Meteorológica Mundial (OMM) a través de la iniciativa Vigilancia Global de la Crósfera (Global Cryosphere Watch - GCW). Los co-patrocinadores incluyeron el Ministerio de Relaciones Exteriores de Chile (MINREL); la Universidad de Magallanes, Chile (UMAG); la Dirección Meteorológica de Chile (DMC); la Dirección General de Aguas (DGA); la Universidad de Talca, Chile (UTAL); y la empresa Geoestudios, Chile.

Se desarrollaron sesiones GCW y CryoNet durante los Días 1 y 2 en el Salón O'Higgins, Ministerio de Relaciones Exteriores de Chile, con presentaciones de expertos de todos los países participantes. El Día 3 se desarrolló un trabajo de terreno en los centros de esquí Valle Nevado y El Colorado, 60 km al este de Santiago, visitando estaciones meteorológicas y nivométricas operadas por la Universidad de Chile y la DMC, y realizando experiencias prácticas sobre la caracterización del manto de nieve.

La inauguración de la sesión incluyó palabras de bienvenida del Dr. Zhang Wenjian, Director del Departamento de Observación y Sistemas de Información de la OMM; el Sr. Guillermo Navarro, Director de la DMC; el Dr. Gino Casassa en representación del Rector de la UMAG; el Dr. Cedimir Marangunic, Director de Geoestudios; y el Ministro Consejero José Fernández, Subdirector de Asuntos Marítimos y Recursos Naturales, Dirección de Medio Ambiente y Asuntos Marítimos, MINREL. La Sra. Mercedes Meneses, Jefa del Departamento de Asuntos Ambientales del MINREL, realizó una introducción en representación del Comité Organizador Local.

Las diferentes sesiones los Días 1 y 2 fueron lideradas por el Dr. Arni Snorrason, Jefe, y el Dr. Barry Goodison, Subjefe del Grupo Directivo de GCW; el Dr. Wolfgang Schoener, Jefe del Grupo CryoNet; el Dr. Jeff Key, coordinador del plan de implementación de GCW; el Dr. Miroslav Ondras, Jefe de la División de Observación de Sistemas de la WMO; y el Dr. Gino Casassa, miembro del Grupo Directivo de GCW.

El objetivo principal del 1er Taller CryoNet Sudamérica fue identificar estaciones/sitios que podrían ser seleccionados para la red CryoNet de Sudamérica, discutir prácticas que podrán ser aplicadas y promover el desarrollo de actividades criosféricas en la región.

Una sesión final del Día 2 fue dedicada a la revisión de reglamentos ambientales relacionados con glaciares y el ambiente periglacial en los diferentes países representados en el Taller, un tema de particular relevancia para Chile a la luz de la iniciativa de la ley de glaciares que está actualmente siendo debatida en el Congreso. Se recalcó la necesidad de definiciones criosféricas adecuadas en vista de sus implicancias legales.

Se convino en los siguientes acuerdos y puntos de acción:

1. Existe alto interés en la región en contribuir a la iniciativa CryoNet.
2. Se elegirán inicialmente Representantes Nacionales de CryoNet Sudamérica entre los asistentes e invitados al Taller, en coordinación con los corresponsales nacionales de la Asociación Internacional de Ciencias Criosféricas (IACS).
3. Gino Casassa, el Representante Nacional para Chile, realizará el seguimiento al punto 2.
4. Cada Representante Nacional contactará a sus respectivas agencias, instituciones y colegas para recordarles que deberán completar el cuestionario del sitio antes del 25 de noviembre de 2014.
5. Se formará un Grupo Regional por consenso de los Representantes Nacionales.
6. Se incluirá a México en el grupo, y se propondrá el nombre "CryoNet Latinoamérica".

7. Se propondrá una colaboración conjunta con el Grupo de Trabajo de Nieves y Hielos (GTNH) de la sección regional de Latinoamérica y el Caribe (LAC) del Programa Hidrológico Internacional (PHI) de UNESCO.
8. Se propone una 2a reunión latinoamericana de CryoNet en la segunda mitad de 2015.
9. El Grupo regional realizará el seguimiento a las acciones 6, 7 y 8.

Los representantes nacionales fueron nominados para México, Colombia, Ecuador, Perú, Bolivia, Argentina y Chile.

Se concluyó que se necesita en forma prioritaria para Latinoamérica un monitoreo sistemático y de largo plazo de la criósfera, especialmente en vista de los drásticos cambios experimentados por las masas de nieve y hielo a escala continental. En este sentido, CryoNet Latinoamérica proveerá una contribución clave a la iniciativa global CryoNet.



## **1 ORGANIZATION OF THE SESSION**

### 1.1 Welcome and opening of the session

On the behalf of WMO, Dr Wenjian Zhang, the Director of the Department of Observation Systems and Information thanked the Minister Councilor of the Chilean government for hosting the workshop. He briefed the meeting with a short overview on the fifty year history of WMO's Programmes noting that the cryosphere is now one of the main priorities of WMO and will be addressed through the Global Cryosphere Watch (GCW). Dr Zhang finally recalled the objectives of the workshop and wished for a fruitful meeting.

Mr Guillermo Navarro, Director of the Chilean Weather Service warmly welcomed all participants. Noting the importance of this workshop for the Chilean government, Mr. Navarro expressed their willingness to contribute to the GCW initiative.

On the behalf of Dr Juan Oyarzo, the Rector of University of Magallanes, Gino Casassa thanked the Chilean government for the support provided in the organization of this workshop. He expressed his satisfaction to see a number of universities' experts participating at the meeting and reaffirmed the willingness of the University of Magallanes thought a quite small university to contribute to this global effort.

Mr José Fernandes on the behalf of the Foreign Affairs Ministry of Chile welcomed all guesses to this workshop. He wished for the meeting to serve to send a strong message to all countries in South America and beyond on how important is to create a synergy between partners to handle climate related issues with a particular emphasis on water management and water supply.

### 1.2 Adoption of the Agenda

The programme for the meeting was adopted with minor amendments. The final agenda is attached as ANNEX 1.

### 1.3 Working arrangements, information for participants and material arrangements

Gino Casassa provided the attendees with some important information related to the meeting venue. A round-table introduction of all participants was made to have a better understanding of the expertise of the participants. The list of participants is given in ANNEX 2.

## **2 STATUS OF THE DEVELOPMENT OF GLOBAL CRYOSPHERE WATCH (GCW)**

### 2.1 GCW Overview

Jeff Key gave an overview of GCW. He first provided the meeting with basics information on GCW stressing the mission and main objectives of this initiative (e.g. developing a network of surface observations called "CryoNet", which builds on existing networks; developing measurement guidelines and best practices; refining observational requirements for the WMO Rolling Review of Requirements; engaging in and supporting, intercomparisons of products). Key detailed the conceptual framework, showed the development history of GCW summarizing previous meetings and workshops already held and finally introduced the GCW Implementation Plan (GCW-IP). He further talked about the GCW teams with a particular emphasis on CryoNet which represents an immediate priority in GCW development and detailed the advantage of being part of CryoNet and GCW:

- Being a CryoNet site means being part of an international, operational, global observing system providing observations of known quality for research and knowledge beyond a site's local region.
- Being part of a global network not only brings better visibility, but also a recognition of the importance of the observations made at your site.
- This in turn can bring better support, either funding or logistical support.
- GCW promotes the exchange of knowledge and data, so CryoNet sites may see broader use of their data and products.

Barry Goodison as vice-Chair of the GCW Steering Group (GSG) mentioned that the GCW-IP will be translated into the six official languages of the United Nations (i.e. Arabic, Chinese, English, French, Russian and Spanish) before the Seventeenth World Meteorological Congress in May 2015.

## 2.2 Role and status of the GCW Steering Group

Arni Snorrason as the Chair of the GCW Steering Group (GSG) presented the role and the status of the Group to the attendees. He described the composition of GSG which encompasses experts from the Executive Council Panel of Experts on Polar Observations, Research and Services (EC-PORS), relevant WMO Programmes, contributors, partners and co-sponsors. Snorrason also made mention that GSG currently reports to EC-PORS.

The task of GSG is to provide high-level guidance on GCW development and implementation. It is concerned with process and general direction more than specific actions. In the near-term, the Steering Group will provide guidance on Task Team formation and on initial GCW activities and tasks to be conducted, given the available budget. The GSG will guide preparation of GCW for discussion at the World Meteorological Congress in 2015.

Some questions arose from the audience on cryosphere terminology and about the GCW National Representatives. Snorrason recalled the importance of harmonizing cryospheric terms and agreeing on unique definitions, if possible. He mentioned that GCW is currently working on a glossary and recalled that much information is already compiled and available on the GCW website. He further mentioned that translation of term between different languages is also an issue to consider.

## 2.3 Status report on CryoNet

CryoNet, which is the GCW surface-based observing network, was presented to the attendees by Wolfgang Schöner. Referring to the conceptual framework diagram, Schöner listed the objectives of CryoNet recalling that it will link with different cryospheric observational networks to achieve its comprehensive potential through a set of actions given below:

- Extensive monitoring of the cryosphere through harmonized measurements
- Providing cryospheric-data for improved process understanding and modelling
- Providing calibration and validation data for satellite measurements
- Linking cryospheric ground truth observations to cryospheric models
- Training for cryospheric observations
- Standardized practices for cryospheric observations
- Long-term, sustainable observing and monitoring.

Schöner summarized CryoNet activities done so far (e.g. meetings and workshops; documents; Questionnaire). He further detailed the site types of CryoNet as follows:

- Baseline sites make measurements of at least one element of the cryosphere; e.g. snow, permafrost, sea ice, or glaciers. Baseline, reference, and integrated sites all make measurements according to GCW methods and best practices. Baseline sites should be targeted toward long-term, continuous measurements.
- Reference sites are the key sites of CryoNet with respect to the assessment of long-term changes of the cryosphere as well as for the validation of satellite data and cryospheric models. In order to be accepted as a reference site for a single cryospheric component, measurements must be done according to GCW practices and the site must have provided continuous measurements over a long period.
- Integrated sites will promote, through worldwide scientific collaboration, progress in the scientific understanding of the physical processes that change the cryosphere. These sites integrate in situ and space-based observations and create platforms of cryospheric observatories. Monitoring at integrated sites may cover multiple components of the cryosphere with a highly process orientated approach. Integrated sites can either be a single station or several stations or field sites covering a larger region.

More details on CryoNet site definition is given on the [GCW website](#).

Answering a question from the audience, it was mentioned that WMO will not provide funding support for sustainability of stations or sites but will encourage and help to get things running through the GCW structure and CryoNet.

#### 2.4 Outcome of the CryoNet Asia Meeting

Barry Goodison provided the meeting with a comprehensive feedback of the first CryoNet Asia workshop held in Beijing, China, in late 2013. The purposes of this session were to continue efforts in implementing CryoNet and addressing identified gaps, with an emphasis on the measurement sites, observations, and issues in Asia. This included, but was not limited to, the “Third Pole Project” region of the Himalayas. Participants of this workshop came from China, Pakistan, India, Japan, Russia, Kyrgyzstan, Kazakhstan, Tajikistan, Uzbekistan, USA, Canada, Austria, Italy, and Switzerland.

As general background, Goodison recalled that an improved and integrated global cryospheric network of surface observations was of utmost importance for assessing the state of the cryosphere.

Gaps identified by the CryoNet community with respect to cryospheric observation and monitoring included (1) lack of harmonization in cryospheric observations, (2) lack of network-hosts for several cryospheric observations (e.g. glacier flow measurements, automatic weather stations on glaciers), (3) lack of guidelines for the measurement of some cryospheric properties, (4) need for improved training, especially at the international level and (5) access to cryospheric observational data.

Goodison summarized the key outcomes from this workshop as follows:

- Draft the site classification system and then try to assign sites submitted by participants to test its applicability,
- Develop a data exchange mechanism,
- Compile appropriate best practices, guidelines, and standards currently being used by different agencies, organizations,
- Identify and pursue funding opportunities. As CryoNet sites would be operated by national entities, it is important to start the dialogue with national ministries to seek commitments to operate these sites,
- GCW CryoNet Asia will follow WMO’s resolution on data policies and data sharing,

- Appoint an Asia CryoNet representative on GCW CryoNet.

The meeting noted that CryoNet stations/sites have to be well maintained in order to be efficient (e.g. a station should be accessible, maintained and people trained). Through a dedicated training workshop, the World Glacier Monitoring Service (WGMS) provided a good example of how people can be trained to make cryospheric measurements. WMO supported this initiative. Similar action should be implemented in South America.

### **3 CRYOSPHERIC ACTIVITIES IN SOUTH AMERICA**

#### **3.1 Presentations by South American participants**

Presentations given during this session are briefly described below (classified by country and name of speaker).

##### **Argentina (Sandra Barreira)**

Title: “Cryospheric activities in South America”

Description: This presentation included the following topics: sea ice fields, comparisons of Satellite with observations; development of forecast products, temporal series of sea ice around Antarctica; sea ice correlation with surface pressure and air temperature; data quality control and storage; daily sea ice edge on Ice Portal; Training on Sea ice and iceberg observer and the Antarctic navigation, provide a list of stations in Argentina including the Antarctica, some of them are meteorologic stations; all stations are on GTS providing SYNOPs; info on ice breakers and measurements of meteorologic parameters but not on GTS; list of research activities in the Antarctic; more stations exist in the Antarctic but operating in summer only.

##### **Argentina (Dario Trombotto Liaudat)**

Title: “Environmental status of the cryogenic permafrost conditions in the last decade in the Central Andes, one example: Morenas Coloradas rockglacier, Mendoza, Argentina”

Description: This presentation included the following topics: map of the main regions of permafrost; monitoring sites; data not continuous and not supported by the government, resources are needed; example of site Morenas Coloradas rock glacier – boreholes, thermometers, etc.; collaboration with neighbors countries e.g., Bolivia, Chile, etc.; model of rock glaciers environment in the Central Andes; some met stations in this area; information on instruments for measurements used; top of the permafrost – Balcon; depth of the permafrost; reduction of the permafrost depth.

##### **Argentina (Mariano Masiokas)**

Title: “Actividades recientes del IANIGLA relevantes para el programa CryoNet”

Description: This presentation included the following topics: the National Law 26639 entitled “Presupuestos Mínimos para la Preservación de los Glaciares y del Ambiente Periglacial” (Minimum Standards for the Preservation of Glaciers and Periglacial Environments). New glaciers inventory and snow fields; 5 regions within Argentina (Desert Andes, Central Andes, Non-Patagonian; south Patagonia, Tierra del Fuego); studies of fluctuations, measurements of mass balance, met and hydro observations of 4 selected glaciers; database exist; 5 new AWS will be installed in the vicinity of studies; 1<sup>st</sup> station - Aqua Negra with existing AWS

Ceaza and AWS Inigla and AWS Aqua Negra; 2nd Lag del Diamante with two AWSs, e.g. AWS Vuricholes, AWSAlmohadila, 3<sup>rd</sup> Glacias de los Tres with several AWSs.

**Bolivia** Alvaro Soruco & Antione Rabatel (France)

Title: "Study of Bolivia Glaciers"

Description: This presentation included the following topics: tropical glaciers in South America & Africa, history of studies – since 1991; methodology – accumulation and ablation zones, methods for mass balance – direct method by snow pits; indirect way – by pluviometers and stream flow; geodetic methods – estimation of glacier volume change; inventory made in 1991; three glaciers with measurements; lost of surface by 48 % in one of the glacier; Chacalataya Glacier disappeared completely; Zongo Glacier retreat estimated by different ways (geodetic, hydrologic & glaciologic mass balance); water resources of La Paz city – contribution of 50 % of water; collaboration with Bolivia, Ecuador and Peru; scientific conclusions of Bolivia glaciers – climatic scenarios, modelisation of water resources for future.

**Brazil** (Anna Maria Sanches)

Title: "Cryoshere investigations in South America: Brazilian perspectives and contributions for Andes and Amazonia conexions research"

Description: This presentation included the following topics: studies in Andean Cordillera glaciers, mainly in Bolivia in Cordillera Apolobamba, Nevado Illimani & Cordillera Tres Cruces; theoretical model for the present conditions of Bolivian glaciers; precipitation-sampling network over the Amazon basin; studies of isotopes; network to measure rainfall from July 2013 + 4 years; collaboration with USA and France; atmospheric chemistry laboratory.

**Chile** (Gonzalo Barcaza)

Title: "Monitoring Network of Glaciers in Chile"

Description: This presentation included the following topics: construction of monitoring networks; info on distribution of glaciers from IPCC report; levels of observations: inventories, variations of glacier terminus, mass balance and detailed monitoring; new glaciers inventory of South America – not yet published; austral zone has 88 % of glaciers; collaboration with GCOS, GTN-G, UNFCC, IGOS; observation objectives: climate change studies, modeling, climate reference data are reducing, need to standardize measurements; focus on ECVs, six meteorological stations with Satellite IRIDIUM (for mobile stations) and GOES communication; AWS close to glacier fully equipped; another AWS stations on the Tyndal Glacier and Bello Glacier – portable & communications through IRRIDIUM; AWS at Laguna San Rafael – communications through GEOS; plus eight other stations; logistics difficult - transport also by helicopter; concept for a future network in Patagonia; research station on San Rafael Glacier; data available on website and for free download.

**Chile** (Jorge Carrasco)

Title: "The need of a cryospheric network in Chile"

Description: This presentation included the following topics: precipitation and temperature monitoring respectively since and 1901 and 1911; impact on some glaciers; reduction of glaciers & mass balance; climate prediction for South America; only one station of mass balance in Chile installed by scientific community and it is there for 10 years; no one knows what is the current network monitoring changes in the Cryosphere in South America – there

is no sharing of this info; atmospheric data, altitude zero isotherm, precipitation, equilibrium line, snow; sonic ranging sensor for measurement snow depth in test and could be installed in field; Strong need to establish Cryospheric network in South America; need to rescue data and archiving issue.

**Chile** (Gino Cassasa)

Title: “Glaciology in Chile”

Description: Changes in the Cryosphere; glacier monitoring on Mocho- Choshuenco volcano.

**Chile** (Fabrice Lambert)

Title: “PISAC (Pollution and its Impacts on the South America Cryosphere)”

Description: This presentation included the following topics: project of different countries, multi-disciplinary; investigation of the impacts of black carbon (BC) and co-emitted pollutants in the Andean and Patagonian mountains; 100 million people depending to certain extent on cryosphere glaciers sources; BC can contribute to glacier melts; no studies were done in South America so far therefore PISAC; pollutants from cities transport to high mountains; other emission from wildfires, biomass burning, urban emissions from mobile sources (cars, ships, aircraft, etc) and volcanoes; need emission inventories; need measurement and monitoring stations where GCW can help; will install new AWS to monitor along the Andes; large stations or a lot of small stations – to be decided; samples taken by climbers during field campaigns; high level GAW stations Chacaltaya in Bolivia is a good example but very expensive; glacier monitoring - GCW to develop standards and to be integrated with international standards; new monitoring stations around Santiago - a new campaign project just finished; other part of the work is modelling for analysis and projections; cost benefit analysis of potential mitigation measures; white paper on BC to be distributed to the governments of South America; challenges – lack of emission data, limited monitoring stations, lack of human and financial resources, open to collaborate on post-docs.

**Chile** (Cedomir Marangunic)

Title: “Observations and Measurements – common problems”

Description: This presentation included the following topics: problem of definitions - differences, e.g. GTOS (2007) Glacier, UNESCO-IACS (2011) Glacier, IPCC (2013) Glacier; solution is needed urgently – GCW should help, based on the existing definition (glacier is created by compression of snow) Chile does not have Glaciers because they are not created that way! New measurement methods are also needed – e.g. where to place an ablation stake in a penitents field for mass balance to be measured every year? Why not every two years since within a short term the number of monitored glaciers may be doubled? Country sharing the same glaciers can agree on a common glacier monitoring programme? Need to share experience in instruments and methods through CryoNet; training is important but there are very few professional courses; experiments are needed in searching for new techniques to prevent glaciers; relocation of glacier happened in Chile – relocated 30,000 m<sup>3</sup> of glacier ice where is ablates at 1/3 of its original rate; generating a new glacier at mine.

**Chile** (Gaston Torres)

Title: “Red de estaciones de la dirección meteorológica de Chile”

Description: This presentation included the following topics: mostly measurements of snow; seeking WMO advice on what is needed to monitor; aim is to have a network to measure

snow; few stations in high altitudes; list of stations in Chile Met service network; automatic snow stations – some with staff; 4 stations in altitude Pt Mont, Punta Arenas, plus 2; 15 precipitation stations can contribute to CGW; existing procedures for measuring snow; 8 AWS stations at altitudes but will be more from 900 m to 4000 meters.

### **Chile** (Sebastien Vivero)

Title: “La criósfera en las cuencas semiáridas”

Description: This presentation included the following topics: dry and semi-dry areas of Andes; dry is permanent = permanent conflict for water – agriculture - inhabitants; relevance of water resources is important; study of water resources in the region; study in Valle de Elqui; two types of glaciers – rock and debris-cover free glaciers; ongoing research – installing AWS for turbulent flow, drilling, study of mass balance from 2011 to 2012 on Tapado Glacier; measurements for water content, ablation; three other glaciers where activities are going on; part of SPICE project.

### **Ecuador** (Bolívar Cáceres)

Title: “Cryosphere activities in Ecuador”

Description: This presentation included the following topics: large collaborative parties; country with volcanic structure, 7 glaciers; studied over 20 years; meteorological, climatological, glaciological, hydrological & pluviometric (totalizators) measurements; glacier Antizana 15 alfa – 4800 to 5760 meters; 1.8 km long; monitoring since 1995 and data sent to WGMS; French institution has an observing station here; proposal for CryoNet is Glacier 15 del Antisana – it has sustainability; cooperation with Swiss (equipment for mass balance); support for making measurements every month; modelling for 2050 of temperature and glacier retreat; meteorological data are very good and are validated; Other proposal for CryoNet is a site on Antarctic peninsula on glacier Quito – station established for 4 years; AWS station since 2013; working on real time transmission – not yet success but should be next year Antarctic summer; Ecuador Antarctic Institute has a plan to make this station permanent son.

### **France** (Patrick Ginot)

Title: “Cryospheric, hydrologic, Climate and Antropic impacts in mountain regions”

Description: This presentation included the following topics: main sites – Two in Andes, one in Alps, one in Himalaya and one in Antarctica; three water resources stations; eight stations for ice core archive from high glaciers; Project GLACIOCLIM in Bolivia in Zongo area, stations on the glacier and near the glacier; monitoring hydrologic parameters; aerosol monitoring; glacier fluctuation in Himalaya; estimation of the impact of aerosol deposition on glaciers; concentration of black carbon (BC) in Himalayas; BC increases snow/ice melting; atmospheric monitoring station in Chacaltaya in high Andes (one hour from La Paz, Bolivia) at 5830 meters, a GAW stations with RSO observation; smoke transportation above Andean mountains; future project “Save Ice core for future”.

### **Mexico** (Hugo Delgado Granados)

Title: “Mexican glaciers - Indicators of tropical climate in Mexico”

Description: This presentation included the following topics: two glaciers outside of the Inter-tropical Convergence Zone (ITCZ), not far from Mexico city; study of the conservation and eventual extinction of Mexico glaciers; glaciers are retreating and disappearing; other process different from climate – volcano (e.g. Popocatepetl) eruptions; regional temperature

is going up and precipitation is dropping; Two AWS at 5000 m that are proposed for CryoNet; study on other influencing factor - is ITCZ moving northward?; glaciers will disappear within 4 years some other glaciers within 10 years.

**Peru** (Wilson Suarez Alayza)

Title: "Observing systems of Meteorological Service"

Description: This presentation included the following topics: 1300 Km<sup>2</sup> of glaciers; 18 glaciers; some glaciers are close to Lima but Lima does not depend on water from glaciers; some climate and hydrologic stations in Central part using WMO practices; climate in Peru is dry, therefore mean elevation of glaciers circa 5000 m; climatic station on glacier at 5180 m – logistics difficult; AWS can correct vertical position automatically (gyroscope) and transmit data through GOES; limitations for installation of AWS – slopes, distance, rescue, representative place, etc.; collaboration with national hydrologic authority; also with University of Zurich and others.

**Peru** (Luzmila Davila Roller)

Title: "Actividades glaciologicas en Peru"

Description: This presentation included the following topics: following a catastrophic landslides event the work was initiated on three glaciers, there are other glaciers (together 14); what is the impact of climate on glaciers; in 1941 there were 30,000 victims that lost lives; carry out mass balance calculation manually and by instruments, collaboration with Innsbruck University; monitoring since 1972 and less; use some AWS stations on glacier Artesonaraju; Yanamarey Glacier monitored since 1981 with some AWS around but not on glacier; AWS will be installed to measure weather parameters on some glaciers.

**USA** (Ted Scambos)

Title: "The Automated Meteorology – Ice/Indigenous species – Geophysics Observation System (AMIGOS)"

Description: This presentation included the following topics: collaboration with Argentina first; AWS to be placed on moving ice; AWS with weather sensor, GPS system, camera, thermistor string, albedometer, Linus micro-computer, data storage, Satellite phone transmission, an option radio link and SBD mode for IRRIDIUM communications.

Arni Snorrason as Chair of this session thanked all presenters for this comprehensive overview of South America cryospheric activities. He noted a lot of critical issues that need to be addressed (e.g. water issues, coordination of observations, and agreement on practices) and he mentioned that those issues should be discussed during the break-out sessions.

Note that all presentations (ppt, pdf or word format) are available online through the [Documentation Plan](#) of the workshop.

## **4 PROCEDURE FOR SELECTION OF CRYONET STATIONS OF SOUTH AMERICA**

### **4.1 CryoNet South America Sites Questionnaire & Responses**

In a view to have a more productive workshop, a request for site questionnaires and background documents was sent to participants prior to the meeting. The background



document had to briefly describe the measurement and/or research program developed by a given country and to include the following basics information:

- Short description of the site or program
- Who sponsors your measurements (a national agency, a university, private company)
- What national or international networks you are already part of, if any
- Which components of the cryosphere you measure (snow, glaciers, sea ice, etc.)
- Outlook for your site: will it be sustained for the long-term or is it a short-term site?

Furthermore, in order to have site information readily available at the workshop, participants were also asked to complete the [GCW Site Questionnaire](#) which is an online form for providing many details on sites and on what it is measured. This questionnaire also serves as an “application” to become a GCW site. An example of web pages that are dynamically generated from the information extracted from the questionnaire can be seen on the web page for [Sonnblick, Austria](#).

While general feedback from the questionnaire can be summed up in few points as given below, detailed responses from several countries are made available via the [documentation plan](#) of the workshop:

- Implementation of tiered network
- High need for standards and guidelines in cryospheric observations (many counts)
- Serve science and practitioners
- Cooperate with existing networks
- Fill gaps in existing networks
- Data policy and data provision

#### 4.2 Procedure for Selection

W. Schöner recalled what kind of basic requirements a given surface measurement site or station must meet in order to be included in CryoNet. One of these criteria cited here as an example stipulates that:” CryoNet sites have to be active and perform sustained observations according to CryoNet agreed practices. There must be a commitment to continue measurements for a minimum of four (4) years”. The complete list of requirements for site inclusion in CryoNet is provided in the [GCW website](#). Schöner further noted that contributing sites, which are part of the GCW surface network but not part of CryoNet, only need to meet the data sharing requirement.

## 5 POTENTIAL STATIONS OF CRYONET SOUTH AMERICA

W. Schöner and A. Snorrason chaired the break-out sessions. Main purposes of the break-out sessions were to identify needs for GCW CryoNet activities and, based on this, to identify suitable sites for CryoNet. Sessions were initially planned to follow a geographical and environmental sub-division structure (Tropical Andes, Antarctic Peninsula and Southern Ocean islands, Dry and Wet Andes). In fact, discussions revolved around several questions previously developed and addressed during the first CryoNet Asia Workshop in Beijing, China:

1. Should a focus be on the Andes as one region, or by three climate zones – tropical, dry, and wet Andes?

Several participants thought that this region should be considered as a whole while many others asked to distinguish inner and outer tropics areas. The International Association of

Cryospheric Sciences (IACS) and the Pollution and its Impact on the South American Cryosphere initiative (PISAC) for example, would support just one South America region not partitioned by climate zones. For practical reasons the meeting decided to consider the cryospheric observations made in the Andes as a whole ensemble in CryoNet South America.

2. Should Antarctic stations/sites operated by South American countries be part of South American CryoNet or Antarctic CryoNet?

Though the Antarctica Peninsula can experience a similar climate conditions than Patagonia, attendees agreed that Antarctica should nevertheless be considered separately from CryoNet South America since from a geographically point of view it is a completely distinct region and also because several countries outside South America are involved. J. Key reaffirmed that CryoNet is global and should not be divided into regions. C. Fierz recalled that by the Antarctic Treaty all data from the Antarctic are freely available.

3. Should Mexico be included in this region or be part of North American region??

The meeting noted that Mexico is an issue as. Though limited, cryosphere in tropical zones and its observation constitutes an important aspect to properly assess links to climate change. In fact, CryoNet is not building a rigid regional network and Mexico may be included in CryoNet South America though this country belongs to North America. However, impacts of Mexico glaciers should be weighted in comparison of the rest of the South America cryosphere. Nonetheless, a solution to tackle this issue would be to simply rename CryoNet South America to CryoNet Latin America.

4. Should CryoNet South America be organized similarly to WMO RA III Regional Basic Synoptic Network?

The meeting agreed that CryoNet will be just one global network.

5. CryoNet Sites/Stations proposed by participants

W. Schöner provided the meeting with an explanation of the three classes of CryoNet sites along with the minimum site requirements. Finally, participants proposed stations and sites for inclusion in CryoNet (see table below):

<b>Country</b>	<b>Station/Site</b>	<b>Type</b>	<b>Comments</b>
Argentina	Zongo glacier	reference, integrated	Will review again and may update site Questionnaire
Argentina	Morenas Colorado Rockglacier	reference	In future it may be integrated
Argentina	Base Belgrano II	reference	
Argentina	ARA Subofficial Castillo	baseline	With intention to be reference site
Argentina	ARA Puerto Deseado	baseline	With intention to be reference site
Argentina	ARA Almirante Irizar	baseline	With intention to be reference site
Argentina	Base Esperanza	baseline	With intention to be reference site
Argentina	Base Jubany (Carlini)	baseline	With intention to be reference site

Argentina	Base Marambio	baseline	With intention to be reference site
Argentina	Base Orcadas	baseline	With intention to be reference site
Argentina	Base San Martin	baseline	With intention to be reference site
Ecuador	Antisana15 Alfa	integrated	
Ecuador	Traub Glacier (Quito)	baseline	(in the Antarctic). Have long term commitment
Mexico	Glacier Norte	baseline	With intention to be reference site, or integrated in future, there is no staff on site yet
Peru	Gueshgue	contributing	
Peru	Quelccaya Ice Cap	baseline	
Peru	Yanamarey	contributing	
Peru	Artesonarju	baseline	

## 6 OBSERVATIONS & MEASUREMENTS (practices applied in South America)

6.1 Standards and best practices for cryospheric measurements used by GCW – A work in progress.

W. Schöner briefly reviewed the GCW standards and best practices for cryospheric measurements that are currently being compiled. He mentioned that GCW is building on existing measurement methods and noted that most guidelines have been written when observations were mainly done manually. Final standards and best practices will be defined in engaging scientists and site managers. An initial inventory of existing documents describing measurement practices can be found in the [GCW website](#).

6.2 Current methods of measurement of the cryosphere in South America – consistency and issues.

Participants were invited to share documents on observation methods and best practices currently used to monitor specific cryospheric components (e.g. snow depth, glacier monitoring etc.) in South America.

It was agreed that those documents be sent to the WMO Secretariat (Miroslav Ondras or Raymond Le Bris) with a copy to Jeff Key. The emails addresses are given below:

To the WMO Secretariat:

[mondras@wmo.int](mailto:mondras@wmo.int) (Miroslav Ondras) or [rlebris@wmo.int](mailto:rlebris@wmo.int) (Raymond Le Bris)

To Jeff Key:

[jkey@ssec.wisc.edu](mailto:jkey@ssec.wisc.edu)

## 7 SUMMARY & WAY FORWARD FOR CRYONET SOUTH AMERICA

7.1 Summary of break-out sessions

This session was chaired by A. Snorrason assisted by W. Schöner and G. Casassa. They noted with appreciation the very active participation of the attendees. Among several items discussed during the break-out session, they noted that one of the main issues expressed by participants relates to the understanding of the CryoNet structure and its requirements. This,

therefore, required a particular attention and communication as well as explanations have to be improved.

Mains decisions taken during the break-out sessions encompass the points listed below:

- Antarctica will be considered separately from CryoNet South America due to the fact that from a geographically point of view it is a completely distinct region.
- The cryospheric observations made in the Andes are considered as one ensemble in CryoNet South America.
- Mexico will be included in CryoNet South America and the network is renamed CryoNet Latin America.
- A second CryoNet Latin America workshop is proposed to be held in the 2<sup>nd</sup> half of 2015.
- Nomination of national representatives from South America countries:

<b>Country</b>	<b>Name</b>	<b>Institut</b>
MEXICO	Hugo Delgado	Universidad Nacional de México (UNAM)
COLOMBIA	Jorge Luis Ceballos	Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM)
ECUADOR	Bolívar Cáceres	Instituto Nacional de Meteorología e Hidrología (INAMHI)
PERU	Luzmila Dávila Roller; Wilson Suárez	Unidad de Glaciología y Recursos Hídricos de la Autoridad Nacional del Agua (UGRH-ANA). Servicio Nacional de Meteorología e Hidrología (SENAMHI)
BOLIVIA	Alvaro Soruco	Instituto de Investigaciones Geológicas y del Medio Ambiente (IGEMA), Universidad Mayor de San Andrés (UMSA)
ARGENTINA	Darío Trombotto	Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA)
CHILE	Gino Casassa	Geoestudios & Universidad de Magallanes (UMAG)

## 7.2 Discussion on:

- Data archiving, data policy and data sharing

It was first recalled to the participants that fundamentally GCW is developed under an open and free data policy. Data that are produced with public resources have to be public. This is the case for example for universities and research institutions that use public funds. In fact, most participants agreed on that statement. For Peru it is the same as for Chile, communication and sharing data represent a key aspect. In Argentina, there is a South American association of researchers and data will be freely available, but data will be published after certain time (e.g. delay is 5 years for glaciers, much shorter time for permafrost). P.Ginot mentioned that they also have an open policy for data sharing providing all data freely on website. In case of Mexico, all data from public funds should be free; but this is not fully implemented yet. As salary of researchers depend of the amount of the work they do some resistance emerge to share data freely. This is controversial topic in Mexico. Mexico claimed for a certain time before Mexican scientists can share data from the CryoNet sites.

J. Key recalled that data shared within CryoNet can be accessed through the [GCW Portal](#). This Portal is a web interface that contains information about datasets (metadata), but not the data itself. Instead, it links to datasets that are stored at partner data centres. It is compatible with the WMO Information Service (WIS). It is populated with metadata harvested from a number of contributing data centres, but data remains in the original location and are served through the interfaces supported by the originating data centre. The process of harvesting, filtering and translating metadata is still under development and will be modified through dialogue with contributing data centres and WMO activities organised through WIS and WIGOS. The GCW Portal was developed by the [Norwegian Meteorological Institute](#) ("Metno").

- Further building of CryoNet South America

A. Snorrason mentioned that the process to select sites for CryoNet is in progress and will be finalized in January 2015 at the GCW Steering Group meeting and eventually submitted to Cg-17 or subsequent EC for approval for operation. The meeting proposed several sites/stations in an interactive manner (see table above (§5)). Those sites will be assessed against a set of requirements. Cryospheric surface observation sites currently considered are listed in the GCW Website at:

<http://globalcryospherewatch.org/cryonet/sites.php?category=core>.

Permanent Representatives (PR) of Members with WMO as well as stations/sites managers will be informed on the final decision vetted respectively by the GCW Steering Group and the Executive Council of Polar Observations, Research and Services (EC-PORS).

- Management of CryoNet South America

G. Casassa mentioned that there is an active cryospheric community in South America that wishes to collaborate closely with GCW. CryoNet Latin America should also work on glossary in collaboration with IACS. There is a need to organize the second CryoNet Latin America Workshop after Cg-17. He further noted the opportunity to strengthen the synergy with the Snow & Ice group of UNESCO. He proposed to establish a CryoNet South America Group.

## **8 OBSERVATIONS & MEASUREMENTS**

8.1 Fieldwork on practices and maintenance: A case study with an Automatic Weather Station (AWS) at a cryospheric site in the Chilean central Andes (Valle Nevado ski resort).

Participants were provided with a practical lesson of manual measurement of snow parameters in a snow pit demonstration as well as automatic measurements done by the automatic station operated by the University of Chile.

## **9 CLOSURE OF MEETING**

W. Zhang gave a short presentation on WMO structure (e.g. Congress, Executive Councils, Technical Commissions, and Regional Associations) and summarized the WMO GCW Initiative which he qualified as a new partnership process. He mentioned that WMO is under Economic and Social Council of the United Nations (UN) and that WMO is the UN authoritative voice on the behaviour of the atmosphere with the hope that GCW would be similar for the cryosphere. He recalled that WMO have programmes and GCW should also become a programme. He further mentioned that some technical documents have legal status. W. Zhang congratulated the host and all participants for their outstanding contributions noting that they were the firsts who started this historic process.

Mercedes Meneses as a representative of Ministry of Foreign Affairs thanked WMO for organizing this workshop. She recalled that the only way to make a step forward is to go and work together. M. Meneses reaffirmed that the government of Chile supports GCW and that the Ministry of Foreign Affairs will do what is needed to boost CryoNet.

A. Snorrason closed the meeting by thanking the organizing committee for the work done. He thanked all participants and also the interpreters, technicians and the WMO's Secretariat. He finally suggested to bring a message back home to individual Permanent Representatives with WMO to support the initiative and to communicate to decision makers.

The meeting was adjourned on Tuesday 28 October at 06:45 PM.

ANNEX 1

**DRAFT AGENDA**

**VENUE:** Santiago de Chile, Chile

Monday, 27 October 2014

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09:00-10:00

**1 ORGANIZATION OF THE SESSION**

- 3.2 Welcome and opening of the session
  - a. Dr. Zhang Wenjian, Director Department of Observation Systems and Information, WMO
  - b. Mr. Guillermo Navarro, Director Chilean Weather Service
  - c. Mr. Rector University of Magallanes (probably Gino Casassa on his behalf)
  - d. Ambassador Alfredo Labbé Villa, Director of External Politics, Foreign Affairs Ministry of Chile
- 1.2 Adoption of the Agenda
- 1.3 Working arrangements, information for participants and material arrangements

10:00-10:45

**2 STATUS OF THE DEVELOPMENT OF GLOBAL CRYOSPHERE WATCH (GCW)**

(10 min each)

- 2.1 GCW Overview
- 2.2 Role and status of the GCW Steering Group
- 2.3 Status report on CryoNet
- 2.4 Outcome of the CryoNet Asia Meeting

10:45-11:15 Coffee break and group photo

11:15-13:15

**3 CRYOSPHERIC ACTIVITIES IN SOUTH AMERICA** (10 min each)

- 3.1 Presentations by South American participants

13:15-14:30 Lunch break

14:30-15:30

**3 CRYOSPHERIC ACTIVITIES IN SOUTH AMERICA** (Cont'd.) (10 min each)

- 3.2 Presentations by South American participants

15:30-16:00

**6 PROCEDURE FOR SELECTION OF CRYONET STATIONS OF SOUTH AMERICA**

- 4.1 CryoNet South America Sites Questionnaire & Responses (20 min)
- 4.2 Procedure for Selection (10 min)

16:00-18:00

**7 POTENTIAL STATIONS OF CRYONET SOUTH AMERICA**

- 7.2 Break-out session 1: Tropical Andes: Venezuela, Colombia, Peru, Bolivia
  - 5.2 Break-out session 2: Dry Andes: North-central regions of Chile and Argentina

18:00 Hosted cocktail, 18<sup>th</sup> floor, Ministry of Foreign Affairs, Av. Teatinos 180.

End of the Day

Tuesday, 28 October 2014

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09:00-10:15

**8 POTENTIAL STATIONS OF CRYONET SOUTH AMERICA (Cont'd.)**

- 8.3 Break-out session 3: Wet Andes: Southern Chile and Argentina, including Patagonia and Tierra del Fuego

10:15-10:45 Coffee break

10:45-12:00

**5 POTENTIAL STATIONS OF CRYONET SOUTH AMERICA (Cont'd.)**

- 8.4 Break-out session 4: Antarctic Peninsula and Southern Ocean islands

12:00-13:30 Lunch break

13:30-15:15

**6 OBSERVATIONS & MEASUREMENTS (practices applied in South America)**

- 6.1 Standards and best practices for cryospheric measurements used by GCW – A work in progress
- 6.2 Current methods of measurement of the cryosphere in South America – consistency and issues

15:15-15:45 Coffee break

15:45-18:00

**7 SUMMARY & WAY FORWARD FOR CRYONET SOUTH AMERICA**

- 7.1 Summary of break-out sessions (90min)
- 7.2 Discussion on:  
Data archiving, data policy and data sharing  
Further building of CryoNet South America  
Management of CryoNet South America

18:00 End of the Day

Wednesday, 29 October 2014

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08:00-18:00 (Including Coffee & Lunch breaks)

**8 OBSERVATIONS & MEASUREMENTS**

- 8.1 Fieldwork on practices and maintenance: A case study with an Automatic Weather Station (AWS) at a cryospheric site in the Chilean central Andes (Valle Nevado ski resort)

**9 CLOSURE OF MEETING**

18:00 End of the Meeting



## ANNEX 2

**PARTICIPANTS**  
**1st CryoNet South America Workshop**

#	Last Name	Name	Institution	Country	Email address
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29.	Le Bris	Raymond	WMO	SUIZA	<a href="mailto:rlebris@wmo.int">rlebris@wmo.int</a>
30.	Letelier	Verónica	UMAG	CHILE	<a href="mailto:verónica.letelier@umag.cl">verónica.letelier@umag.cl</a>
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33.	Mella	Francisco	UCh	CHILE	<a href="mailto:jmellatorres@ing.uchile.cl">jmellatorres@ing.uchile.cl</a>
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42.	Quinteros	Jorge	DH, DGA	CHILE	<a href="mailto:jquinteros2@gmail.com">jquinteros2@gmail.com</a>
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44.	Riffo	Carol	CIREN	CHILE	<a href="mailto:criffo@ciren.cl">criffo@ciren.cl</a>
45.	Salazar	Pamela	DGA	CHILE	<a href="mailto:pamela.salazar@mop.gov.cl">pamela.salazar@mop.gov.cl</a>
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47.	Santander	Rodrigo	DMC	CHILE	<a href="mailto:asantander@meteochile.cl">asantander@meteochile.cl</a>
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## ANNEX 3

### **AGREEMENTS AND ACTION POINTS**

1. There is high interest in the region to contribute to the CryoNet initiative.
2. National Representatives of CryoNet South America will be initially selected among the invited participants, in coordination with the national IACS correspondents.
3. Gino Casassa, National Representative for Chile, will follow up on item 2.
4. Each National Representative will contact the respective agencies, institutions and colleagues to remind them to complete the site questionnaire before 25 November 2014.
5. A Regional Group will be formed by consensus from the National Representatives.
6. Mexico will be included in the group, and the name CryoNet Latin America will be proposed.
7. Potential collaboration with the Latin America and the Caribbean (LAC) regional section of the International Hydrological Programme (IHP) of UNESCO will be proposed to the Snow and Ice Working Group of LAC.
8. A 2nd South America meeting is proposed to be held in the 2nd half of 2015.
9. The Regional Group will follow up on items 6, 7 and 8.